United States Environmental Protection Agency

Technology Update #1: Nanotechnology

Nease Chemical Site
Columbiana County, Ohio September 2006

U.S. Environmental Protection Agency selected a remedy to address contaminated soil, ground water and source areas at the Nease Chemical Superfund Site, which requires a combination of treatment, containment and monitored natural recovery (Record of Decision – September 29, 2005). Selected treatment includes the use of nanotechnology – nanoscale zero-valent iron (NZVI) – to remediate VOCs in ground water. Rutgers Organics Corporation, the site owner, has agreed to complete a pre-design investigation of the site as well as the engineering design plans needed for the complex and innovative project. Golder Associates is Rutgers' primary consultant conducting the work. Ohio EPA is providing additional oversight. The pre-design work started in June 2006 and includes an NZVI treatability study.

The geology at the Nease site generally consists of glacial till overburden lying above fractured sedimentary bedrock. NZVI was selected to treat the bedrock ground water and overburden contamination in the southern part of the site. The bedrock plume extends about 1,700 feet from the source areas toward the east. Total VOCs exceed 100 mg/l near the source, consisting primarily of the chlorinated ethane and ethene compounds, as well as benzene and chlorobenzene. DNAPL has been observed in wells near the source areas.

NZVI treatment will involve the injection of a slurry of iron particles in water, through wells into the contaminated aquifer. Contaminants are reduced to non-toxic end products (e.g., ethane). The small particles (ranging in size from 1 to 100 nanometers) have a large surface area compared to volume. The iron particles provide a reactive surface and breakdown of contaminants occurs through oxidation-reduction reactions, with NZVI donating electrons. The particles will remain suspended for some time and flow with the ground water, traveling away from the injection point to create a diffuse treatment zone (including into bedrock fractures). Eventually, the particles will settle and partially dissolve, and their reactivity declines.

NZVI Treatability Study

The NZVI treatability study is being conducted in two phases – a bench scale study and a field pilot test.

The objectives of the bench study are to assess effectiveness of NZVI for the treatment of chlorinated VOCs found on-site, determine the potential of NZVI to treat non-chlorinated VOCs such as benzene and toluene, evaluate potential by-product generation, determine the optimal dosage, evaluate geochemical influences and determine the longevity of NZVI.

The bench scale study involves collection of ground water from a highly contaminated site well, baseline chemical analysis, jar tests to evaluate different formulations (e.g., with and without palladium) and a range of NZVI concentrations in ground water (up to 10 g/L) for rate and effectiveness of

More information

If you are interested in finding out more about the Nease Chemical cleanup project, here are resources:

EPA staff:

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(800) 621-8431 Ext. 64699,
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logan.mary@epa.gov

Susan Pastor
Community Involvement Coordinator
(800) 621-8431 Ext. 31325,
weekdays 10 a.m. to 5:30 p.m.
pastor.susan@epa.gov

On the Web:
www.epa.gov/region5/sites/nease/

You may view site-related documents at the following locations:

EPA Region 5 Records Center
77 W. Jackson Blvd.
Chicago, Ill.

Ohio EPA Northeast District Office
2110 E. Aurora Road
Twinsburg, Ohio

Lepper Library
303 E. Lincoln Way
Lisbon, Ohio

Salem Public Library
821 E. State St.
Salem, Ohio

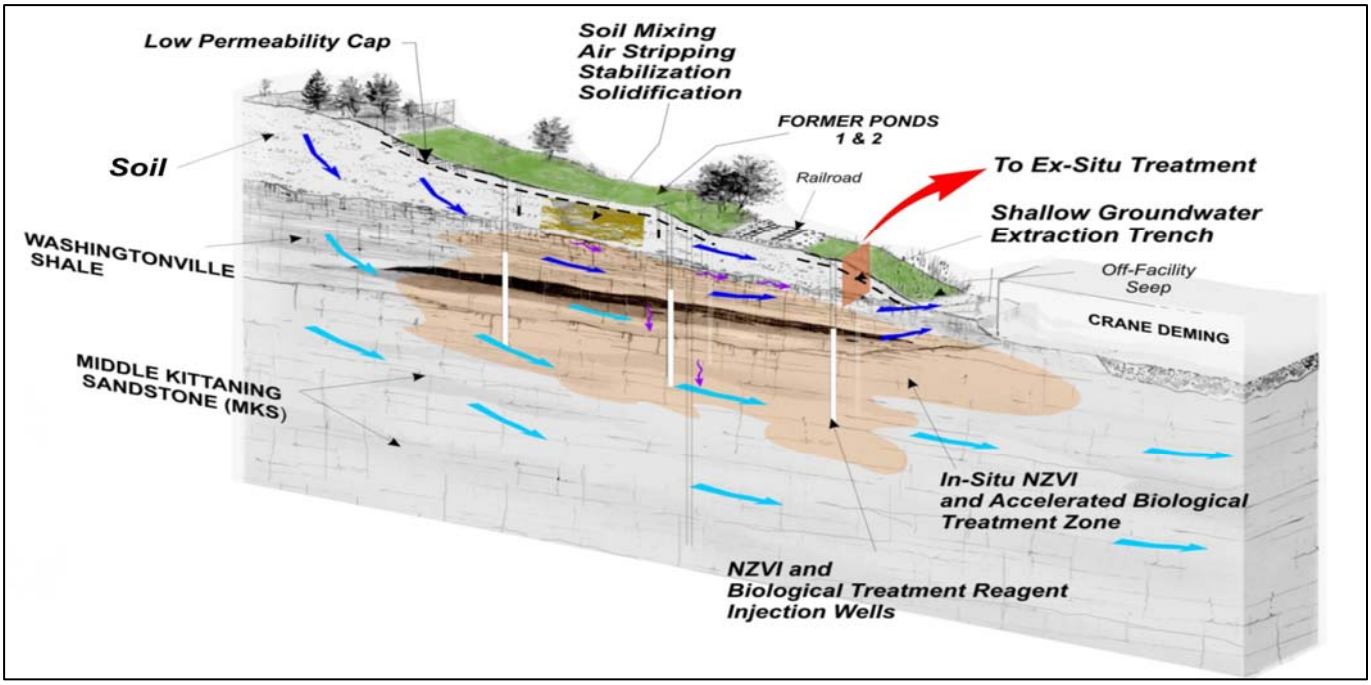

Figure 1: Schematic of selected remedy for soil, source areas and ground water.

treatment, jar tests to evaluate the influence of site soil and rock on treatment, and capacity tests to evaluate treatment of re-contaminated samples. The bench studies were started in July and preliminary results are discussed below.

The objectives of the field pilot study are to verify laboratory results and evaluate treatment under field conditions. The study will confirm in-situ treatment effectiveness, assess geochemical changes in the aquifer and evaluate the rate of transport and dispersion of injected NZVI.

Preliminary Results of Bench Scale Study

Preliminary results after only two weeks of testing show promising results. Baseline, pre-treatment analysis of the test ground water showed total VOC levels well ever 100 mg/L, including about 80 mg/L of tetrachloroethene (PCE) and over 20 mg/L of trichloroethene (TCE). About 200 jar tests have been conducted or are under way.

Bimetallic particles – nanoscale iron coated with about 1 percent palladium (by weight) – worked better in the short term. Rapid reductions in concentrations were seen

with iron concentrations of 2 to 5 g/L. Both chlorinated and non-chlorinated VOCs appear to be treated. No toxic byproducts have been observed. Bench scale work will continue to evaluate the long-term treatment effectiveness of different formulations, including the capacity to continue to treat contaminants.

Next Steps

The field pilot study will be initiated in fall. NZVI slurry will be pressure-injected through a well into a highly contaminated portion of the aquifer. Injection of the iron slurry will occur for several days. Wells installed at close range will be monitored continuously for ground water levels and geochemical parameters. Chemical monitoring will be conducted periodically for at least three months.

Results from the treatability study will be used to design the full-scale system. A technical memorandum summarizing all work will be available in 2007.

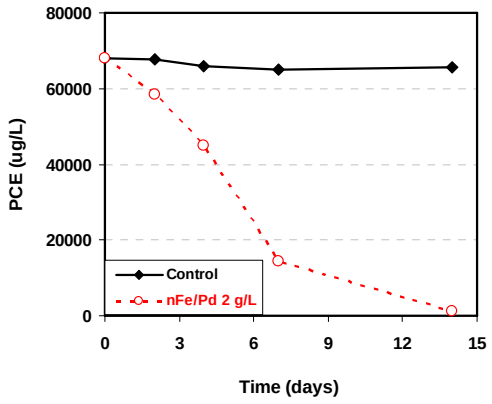

Figure 2: PCE Degradation